

Frontal Crash Protection for Rear Seat Occupants



Shashi Kuppa

May 10, 2006

2006 SAE Government/Industry meeting
Rear Seat and Other Vulnerable Occupants

Objectives

- ❖ Examine the effectiveness of rear seats in mitigating fatality and injury in frontal crashes compared to that of the front seats for different occupant ages.
- ❖ Determine risk of injury and the distribution of injuries to different body regions for occupants in rear seats involved in frontal crashes.

Real World Crash Data Analysis

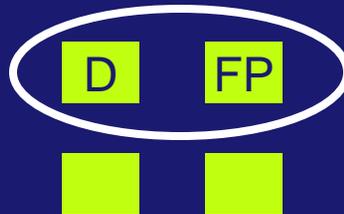
- ❖ Use FARS data files to compare effectiveness of rear seats compared to front seats
- ❖ Use State Data system to compare the risk of injury and death in the rear seats and the front seats
- ❖ Use NASS-CDS to obtain details of injuries, injury causation and mechanisms.

Analysis of Crash Databases

- ❖ Frontal Crashes (rollovers excluded)
- ❖ Passenger Cars and LTVs
- ❖ Model years later than 1991
- ❖ Drivers and outboard front seat and rear seat passengers.
- ❖ Occupants considered restrained if using lap/shoulder belts.
- ❖ Children younger than 5 years old are restrained if in child safety seats.

Double Paired Comparison Study using FARS Data 1993-2003

Group 1

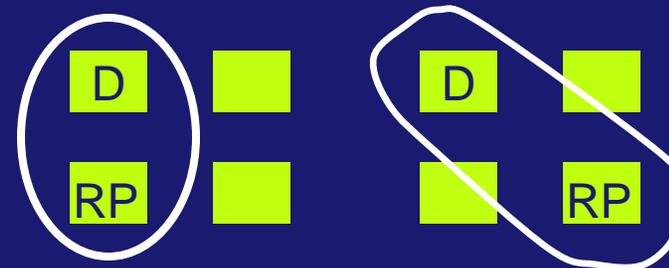


All frontal crashes with driver and front seat passenger where at least one of them died

F1=no. of driver deaths

F2=no. of front pass. deaths

Group 2



All frontal crashes with driver and rear seat passenger where at least one of them died

F3=no. of driver deaths

F4=no. of rear pass. deaths

Groups further divided by passenger age and restraint status

Effectiveness Estimates

$$E = 100 \times \left(1 - \frac{F_4 / F_3}{F_2 / F_1} \right)$$

Effectiveness of Rear Seats Compared to Front Passenger Seat

Restrained Drivers and Passengers



Significance testing using chi-square test

ESV paper no. 05-0212

Effectiveness of Rear Seats Compared to Front Passenger Seat

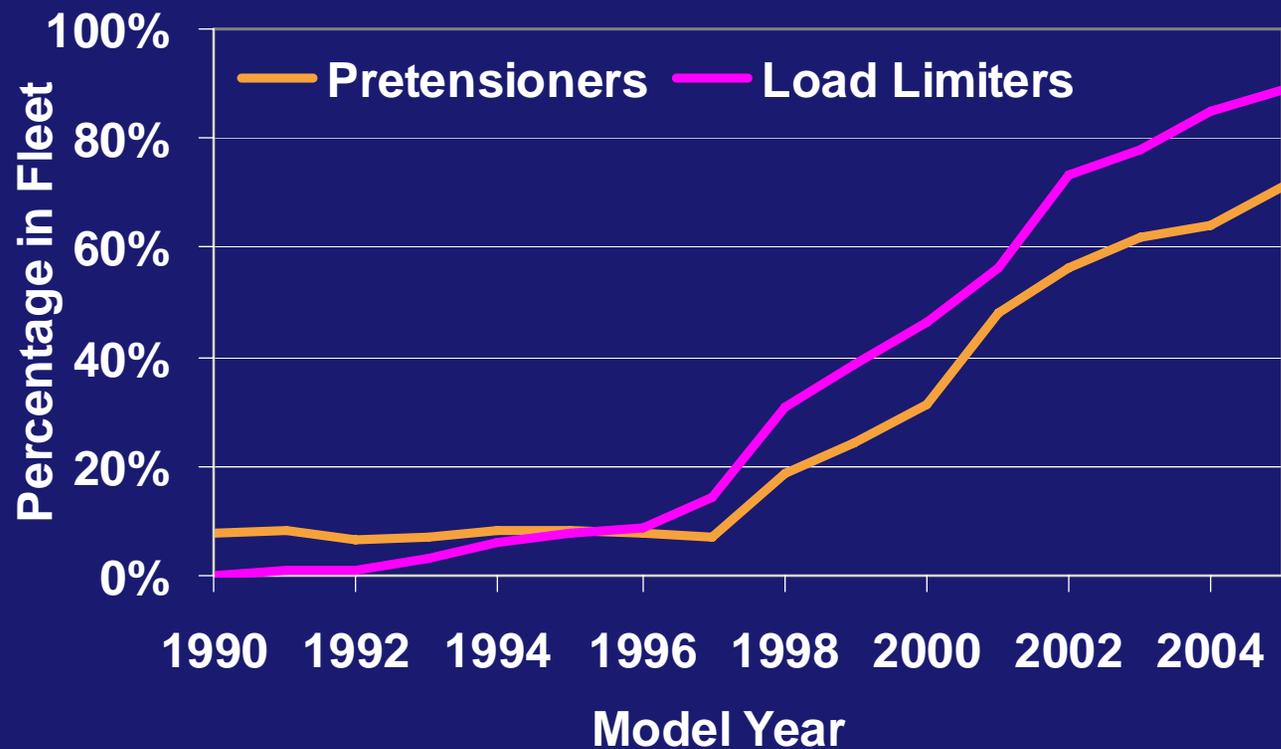
Unrestrained Drivers and Passengers



Significance testing using chi-square test

ESV paper no. 05-0212

Introduction of pretensioners and load limiters in the US fleet

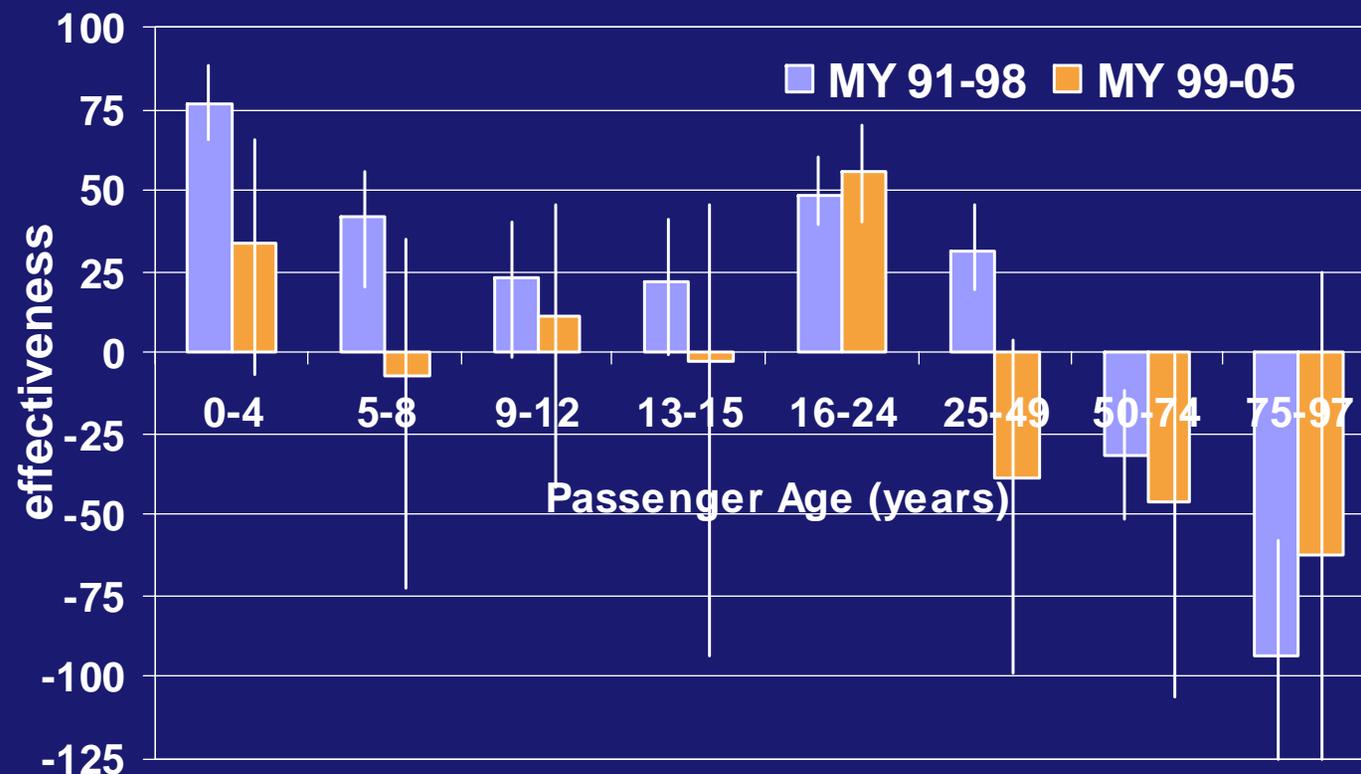


Marie Walz - DOT HS 909 562

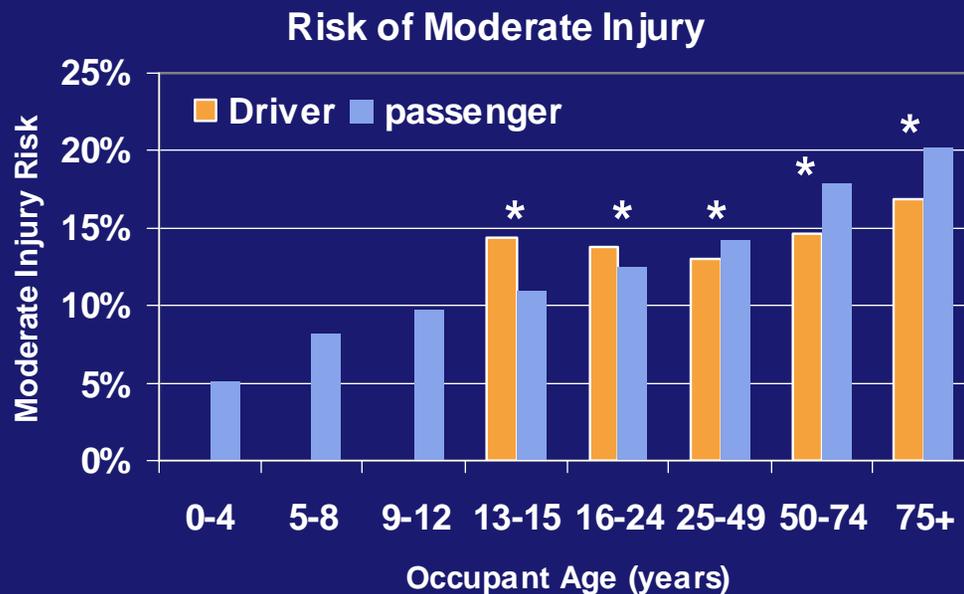
Effect of Vehicle Model Year on the Relative Effectiveness of the Rear Seat (FARS 1993-2004)

Effectiveness of outboard rear seats compared to front outboard passenger seats to mitigate fatalities for restrained occupants.

All vehicles equipped with air bags.



State Data System Analysis – Risk of Injury to Driver and Rear Seat Passenger



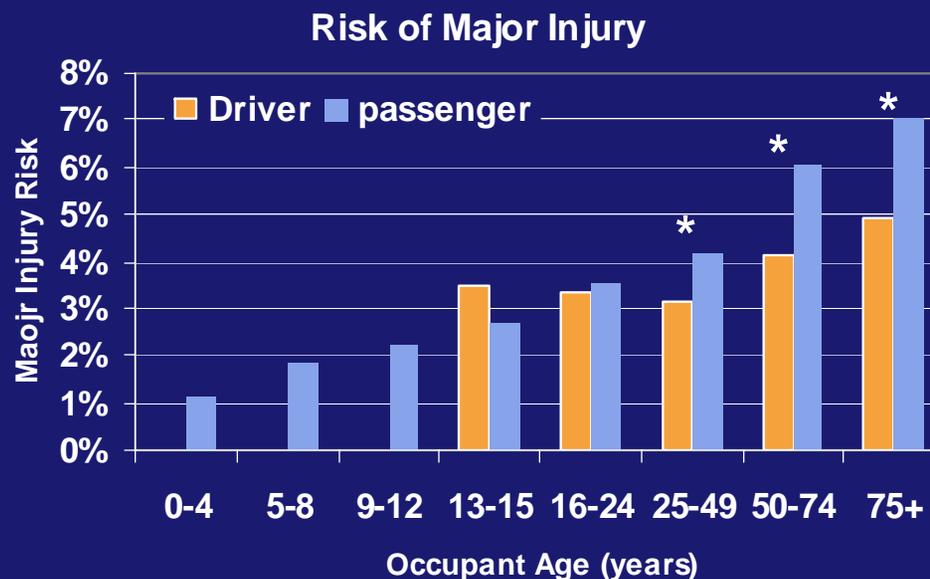
Florida, Maryland, Pennsylvania
 State Data System 1993-2003

* Implies significant difference between driver and passenger risk at a 95% confidence level

Fifty percent of rear seat occupants are children 12 year old and younger

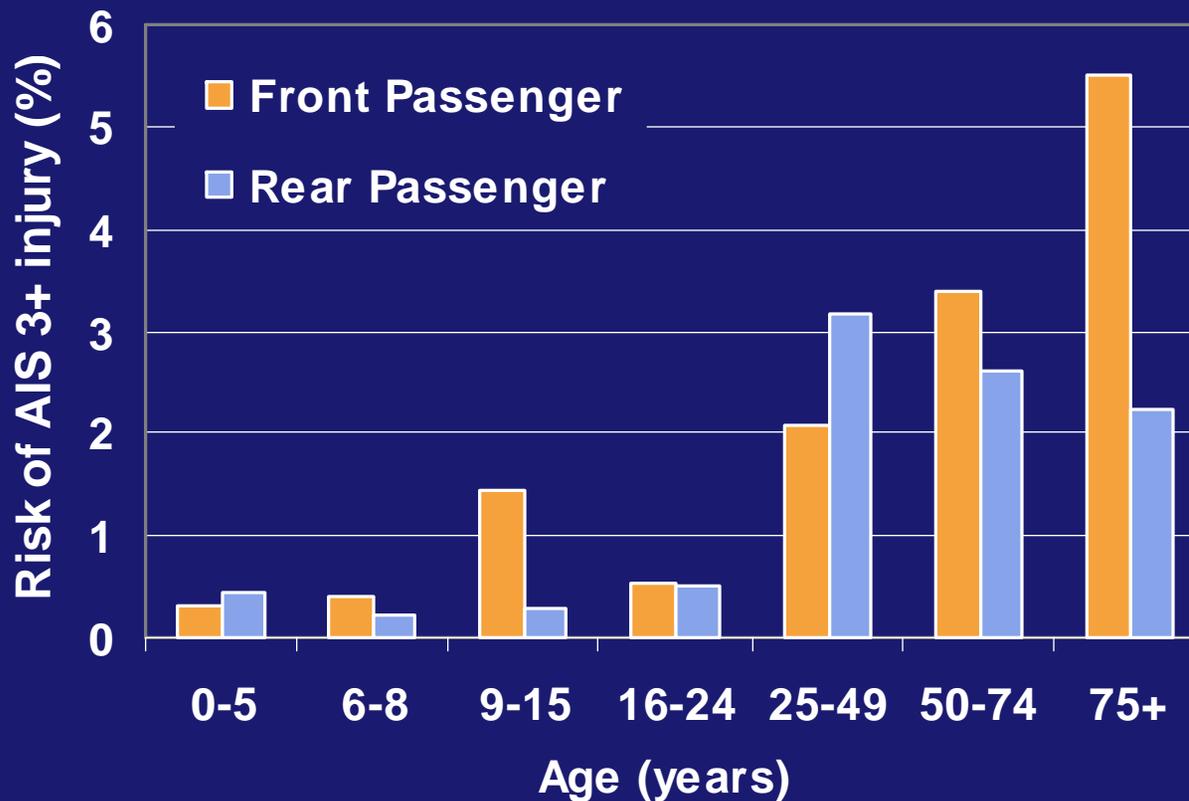
>100,000 drivers

>150,000 passengers



Risk of Injury for Front and Rear Seat Occupants in frontal crashes NASS-CDS

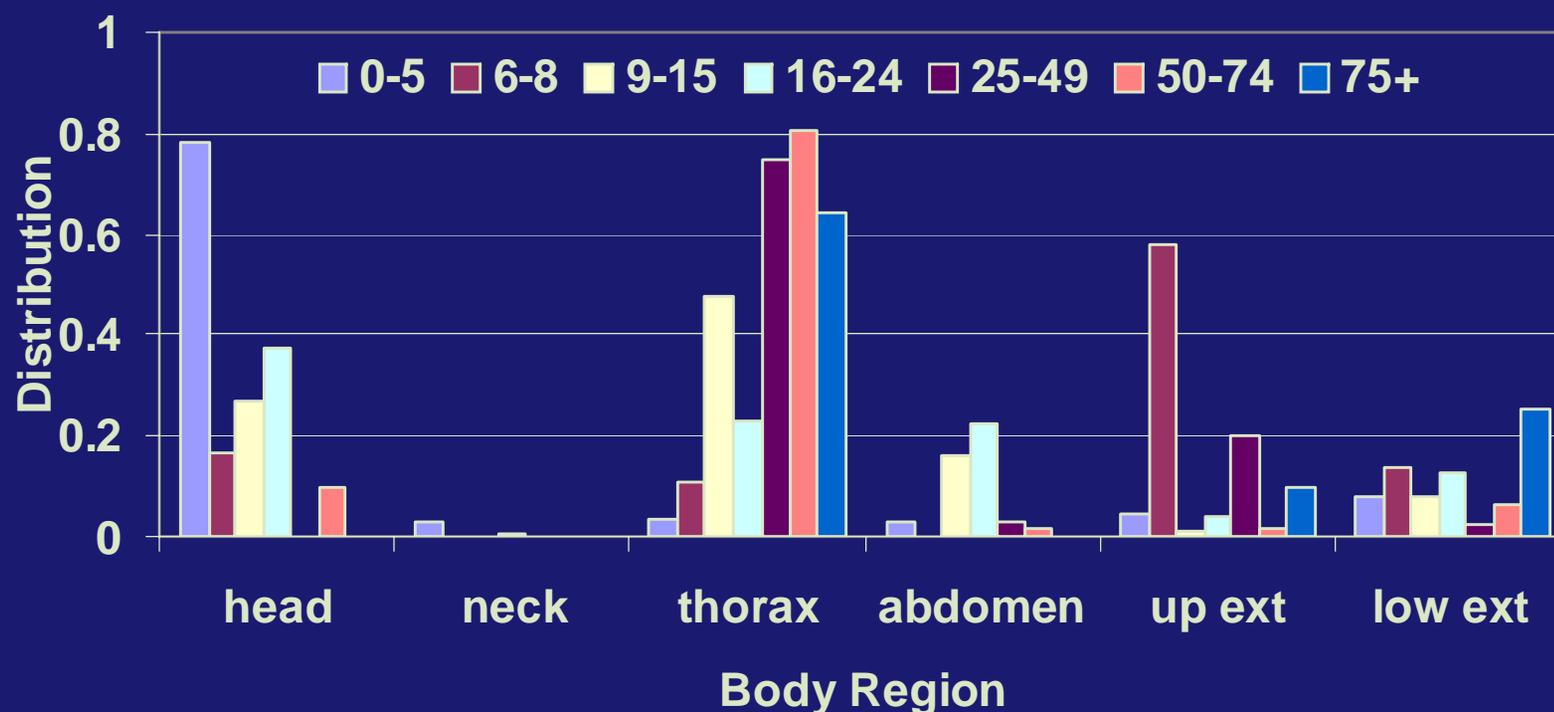
Restrained occupants in MY 1991-2003 Vehicles



64 percent of rear seat occupants are 12 years old and younger and 78 percent weigh less than 160 lbs

Distribution of AIS 3+ Injuries to Rear Seat Occupants by Body Region

NASS-CDS 1993-2003, MY 1991+ vehicles



Major source of head injury for children is the vehicle interior
Major source of chest injury for adults is the seat belt

Summary

- ❖ Restrained occupants older than 50 years of age have significantly improved protection in front seats than in the rear seats.
- ❖ Unrestrained occupants have improved protection in rear seats compared to front seats
- ❖ Presence of front passenger air bag increases the effectiveness of the front seats relative to that of the rear seats for occupants 9 years and older.
- ❖ For newer vehicle models, the front seat position is more effective in reducing serious to fatal injuries for adult occupants in frontal crashes than the rear seat.

Summary

- ❖ Most injured body region for restrained children in rear seats is the head while that for adults is the chest.
- ❖ The main source of chest injuries to the adults is the seat belt.
- ❖ Both FARS and State Data System (SDS) suggest that the risk of injury and death to the restrained older occupant (over 50 years) is higher in the rear seats than the front seats. However, NASS shows otherwise. This may be due to the small sample of rear seat occupants in NASS-CDS.

- ❖ Further analysis of state data –
 - Compare the relative performance of rear seats in vehicles with and without advanced restraints in the front seats (pretensioners and load limiters).
- ❖ Conduct sled tests with dummy and cadaveric subjects in rear seats with and without advanced restraints and improved seat and belt geometry.
 - Examine the effectiveness of advanced restraints and seat and belt geometry in mitigating serious injury to rear seat occupants.
 - Compare dummy responses in different restraint environments in the rear seat and assess its ability to detect injurious events.